crocell A uses much greater power at the second carrier frequency f_2 while microcell B uses little power at the first carrier frequency f_1. This is also shown in FIG. **4**. This shows that a mobile telephone can always be covered by at least one band of one of the microcells while there is little interference between the signals coming from the two microcells to the remote unit since in a single band in the cell the fixed power level areas need not overlap.

Note that handoff of a mobile telephone from one microcell to another can be done more easily by merely switching frequencies. For example, suppose that a remote unit is at location **55** shown in the FIG. **4** and it is using the first carrier frequency f_1 to link with microcell B. Note that it is not getting any interference from the same frequency channel of microcell A. As it roams and moves out of range of the first carrier frequency f_1 of microcell B, the remote unit can be handed off to microcell A using the second carrier frequency f_2. After this switch to the second carrier frequency f_2 of microcell A, the mobile telephone gets little interference from microcell B. This concept can, of course, easily be generalized to many such FDMA channels.

GENERALIZATION TO MULTIPLE MICROCELLS

Suppose that five microcells, denoted "A", "B", "C", "D" and "E", and each of these microcells use a different orthogonal code of 31 codewords each of 32 chips in length. These are five of the six codes described above.

In the area covered by the five microcells, for a given carrier frequency, there are a total of $5 \times 31 = 155$ active radio channels. Suppose for the moment that all five microcell base station radios have equal power at the receiving remote unit. Then the bit energy to noise ratio for the QUALCOMM system is

$$E_b/N_o = 0.42 = -3.81\,\mathrm{dB}$$

while the Welch lower bound gives

$$E_b/N_o \leqq 0.52 = -2.87\,\mathrm{dB}$$

The present invention described here has under the same condition the bit energy to noise ratio of

$$E_b/N_o = 0.50 = -3.01\,\mathrm{dB}$$

The more general situation is where any receiving remote unit sees different power levels from the five microcell base station radios. Let P_A, P_B, P_C, and P_D be the power levels at the slave radio of the remote unit. If the remote unit has an active link with microcell A then it does not receive any interference from this microcell's base station and the equivalent bit energy to noise ratio is

$$E_b/N_o = P_A/(P_B + P_C + P_D + P_E)$$

Recall that for a coded DS/QPSK the required bit energy to noise ratio to achieve a bit error rate of 10^{-3} is $E_b/N_o = 2$. Thus, if we use voice activation circuits then for this remote unit to maintain a good communication channel with microcell A it must have the condition

$$P_A \geqq P_B + P_C + P_D + P_E$$

This result applies to one carrier frequency. At another carrier frequency the power distribution of the five microcell base stations at the slave radio of the remote unit may be quite different. By using different power levels for each FDMA channel by each base station, all areas covered by the five microcells can have adequate power levels to achieve a good communication channel with at least one microcell at some carrier frequency.

In a radio network with many potentially interfering radios simultaneously transmitting in the same band, interference to any given radio is greatest from those with the most power at the receiving antenna of the radio. With equal power transmitters this usually means that the greatest interference comes from transmitters that are closest to the receiving radio. In the prior art all radios contribute the same correlation value while in the present invention the radios in the same microcell use orthogonal codes. Thus, the closest radios tend to have zero cross correlation and contribute no interference. Overall this results in a higher capacity system.

It will be apparent to those skilled in the art that various modifications can be made to the spread spectrum cellular handoff method of the instant invention without departing from the scope or spirit of the invention, and it is intended that the present invention cover modifications and variations of the spread spectrum cellular handoff method provided they come within the scope of the appended claims and their equivalents. Further, it is intended that the present invention cover present and new applications of the method of the present invention.

I claim:

1. A method for handing off a transitioning-remote unit traversing from a first microcell having a first base station communicating with a first plurality of remote units and a third plurality of remote units, with said transitioning-remote unit initially included with the first plurality of remote units, to a second microcell having a second base station communicating with a second plurality of remote units and a fourth plurality of remote units, comprising the steps of:

communicating simultaneously from said first base station to said first plurality of remote units using synchronous, code division multiple access at a first carrier frequency and a first power level with a first plurality of base-communications signals using spread-spectrum modulation with a chip codeword for each spread-spectrum signal orthogonal to all other chip codewords of the first plurality of base-communications signals;

communicating simultaneously from said first base station to said third plurality of remote units using synchronous, code division multiple access at a second carrier frequency and a second power level greater than the first power level with a third plurality of base communications signals using spread-spectrum modulation with a chip codeword for each spread-spectrum signal orthogonal to all other chip codewords of the third plurality of base-communications signals;

communicating simultaneously from said first plurality of remote units to said first base station using synchronous, code division multiple access with a first plurality of remote-communications signals at the first carrier frequency using spread-spectrum modulation with a chip codeword for each spread